THE DETECTION OF FATIGUE CRACKS IN OFFSHORE STRUCTURES UTILIZING THE RANDOM DECREMENT TECHNIQUE

by

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ABSTRACT

Title of Thesis: The Detection of Fatigue Cracks in Offshore Structures Utilizing the Random Decrement Technique

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Thesis directed by: Dr. Jackson C.S. Yang
Professor of Mechanical Engineering

Offshore structures, necessary for the search and production of oil and gas, will be constructed in more hostile environments and at greater depths. Insuring the safety and structural integrity of such structures is of growing concern. Deepsea diving procedures, necessary for visual inspection and repair, are increasingly dangerous and costly at greater depths.

More comprehensive inspections will be required, necessitating alternate methods of structural monitoring. This paper describes the Random Decrement technique of crack detection. The method utilizes naturally occurring structural vibrations (wind, water and operating equipment) to define a 'signature'. Variation from a baseline signature indicates crack initiation and propagation.

Fatigue cracks were initiated at 'water level' in elements of a large, scale-model four-leg offshore platform. Responses of accelerometers placed at several locations on the structure, to random excitation, were analyzed by the Random Decrement computer. These sig-

natures were then compared to the base line responses.

The method was seen to be easy to implement, using transducers mounted on the structure above the water line. With further research, it is expected that the technique will be used to pinpoint structural failure, easing the job of the undersea repair crews.

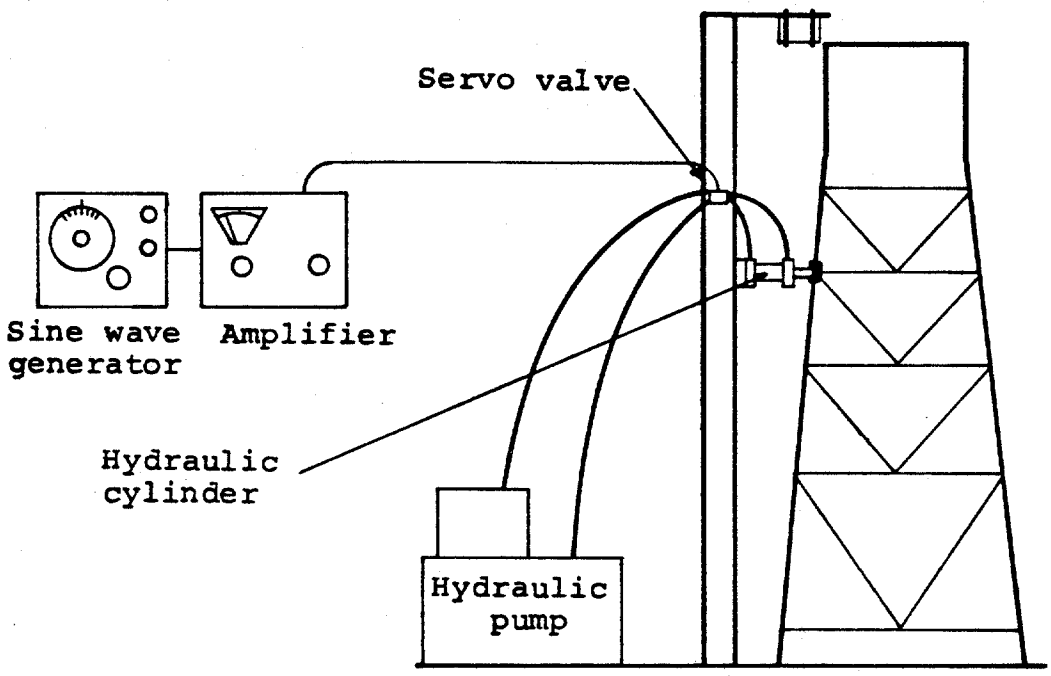


Figure 3a: Schematic of dynamic loading of platform

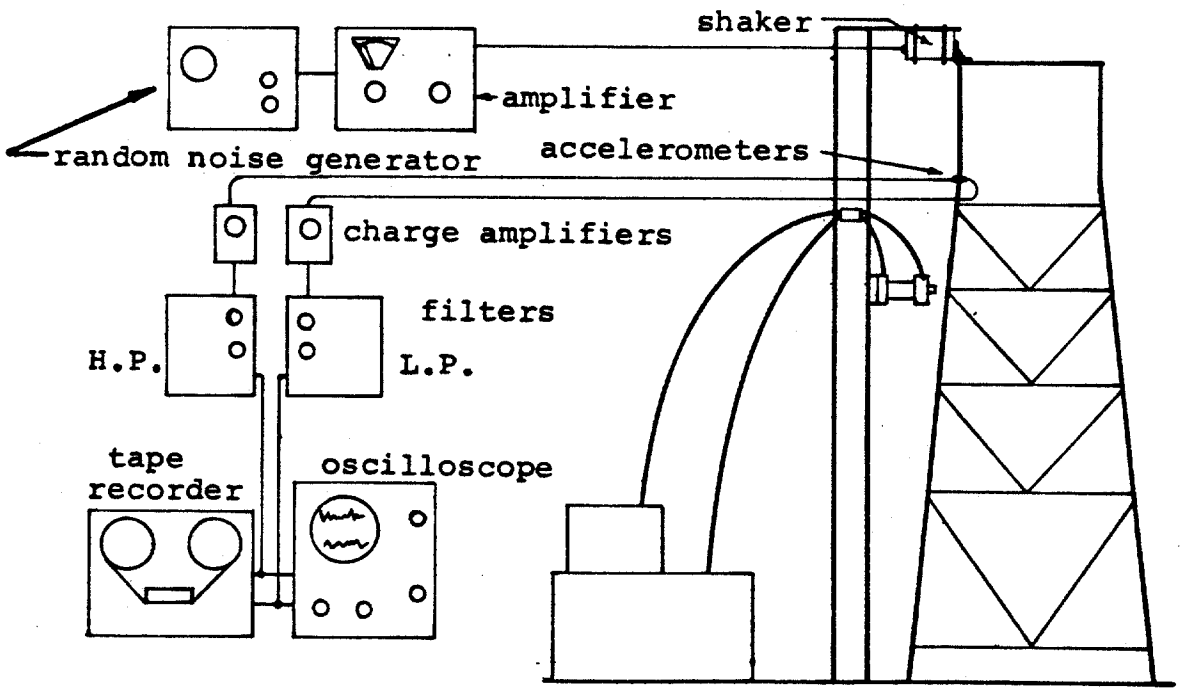


Figure 3b: Schematic of random noise excitation and transducer output recording

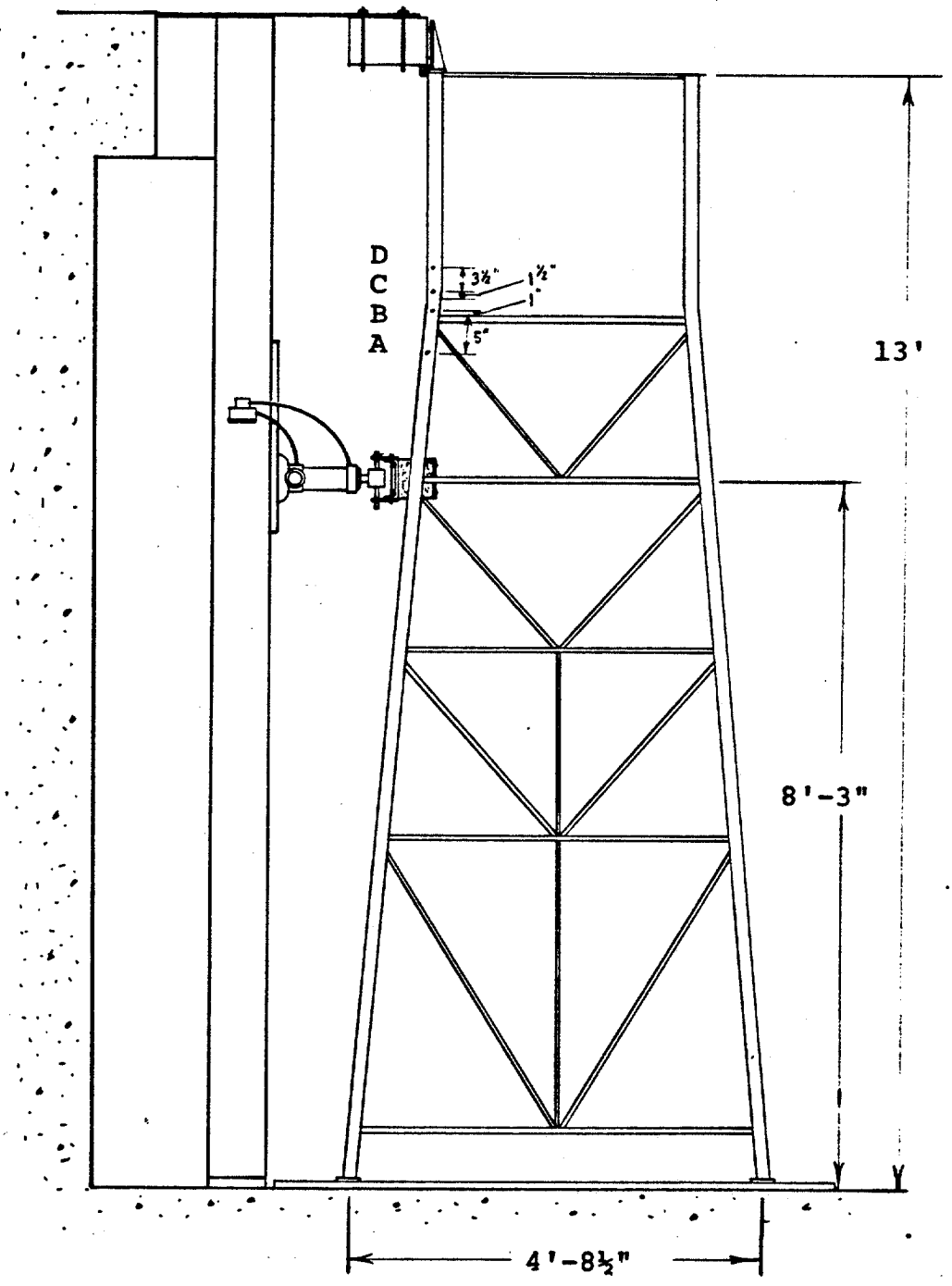


Figure 4: Platform elevation view showing location of accelerometers (leg 1 only)

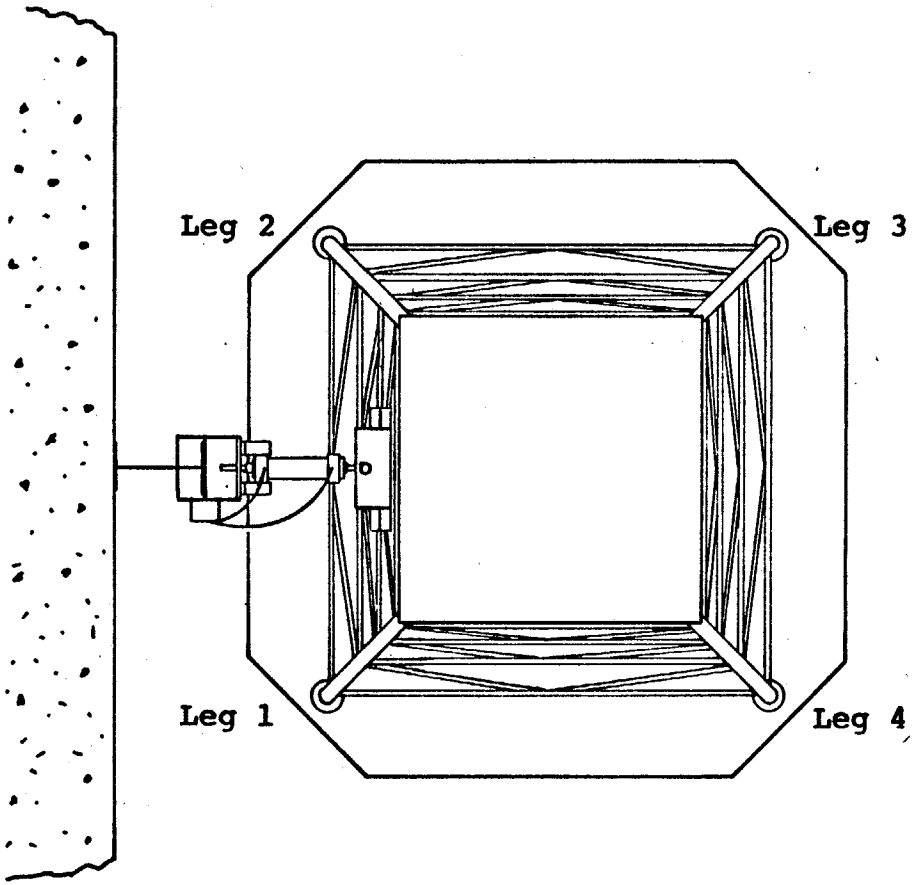


Figure 5: Platform plan view with shaker and mounting beam removed

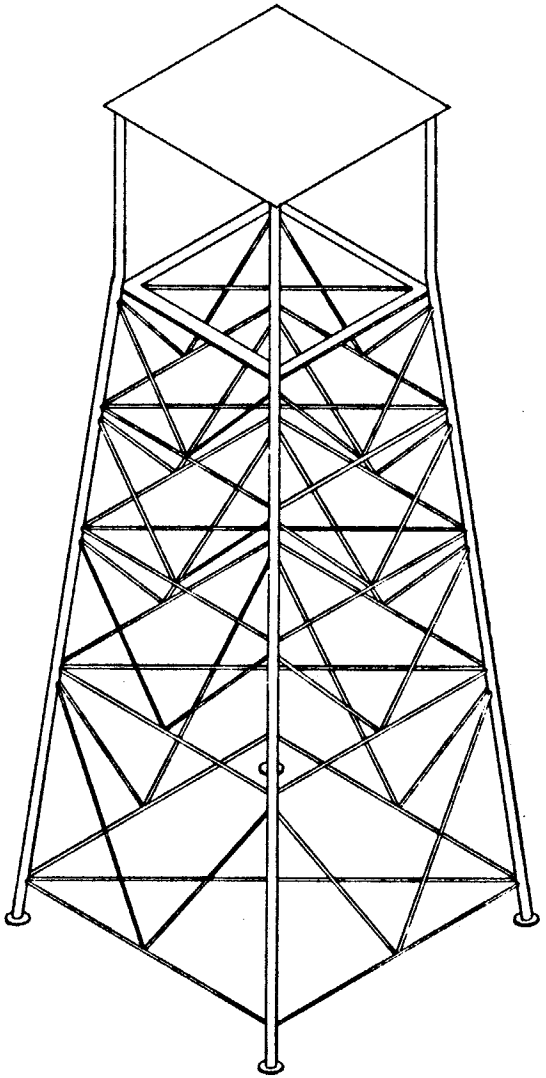


Figure 6: Platform isometric view

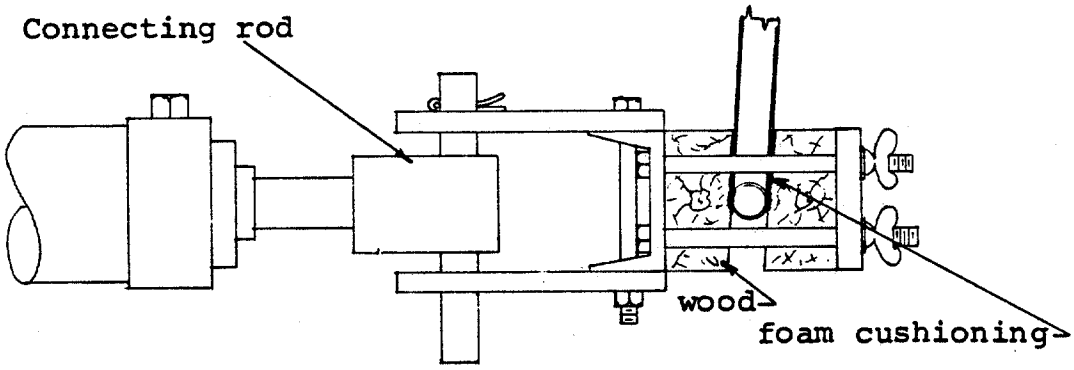


Figure 7: Detail of hydraulic cylinder-platform connection

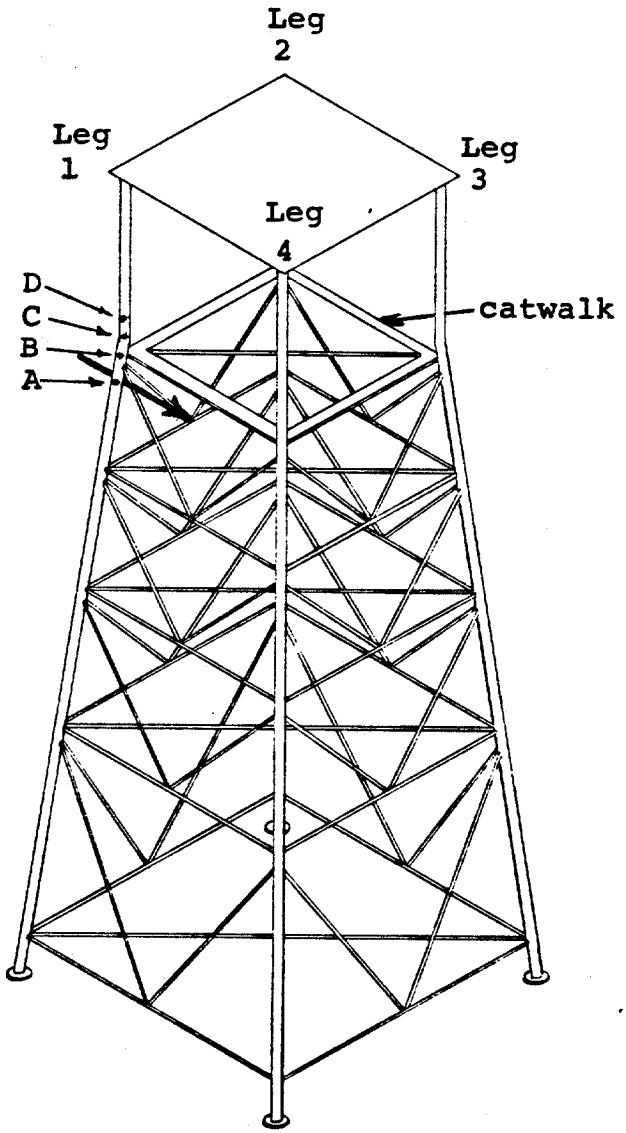


Figure 9 : Accelerometer locations and position designations

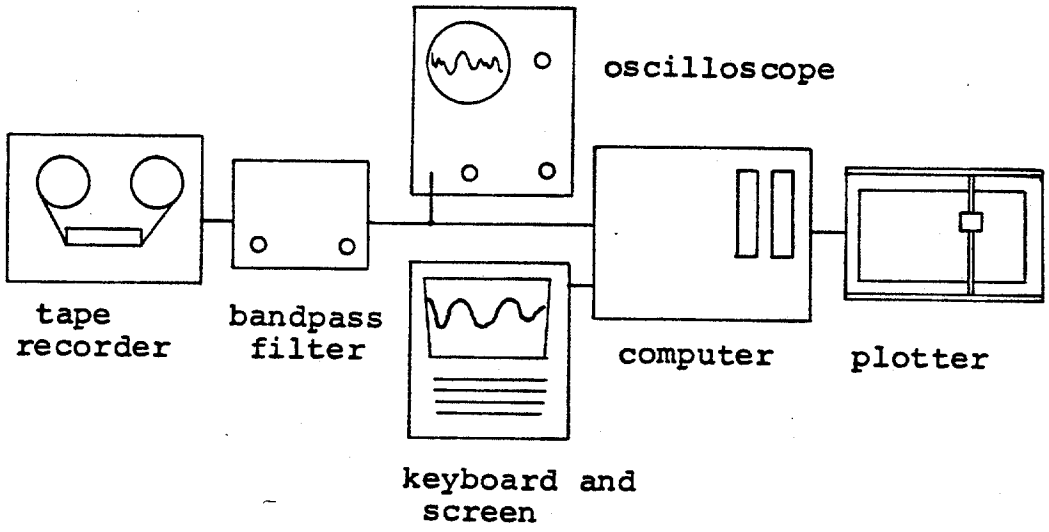


Figure 10: Schematic of Randomdec analysis equipment

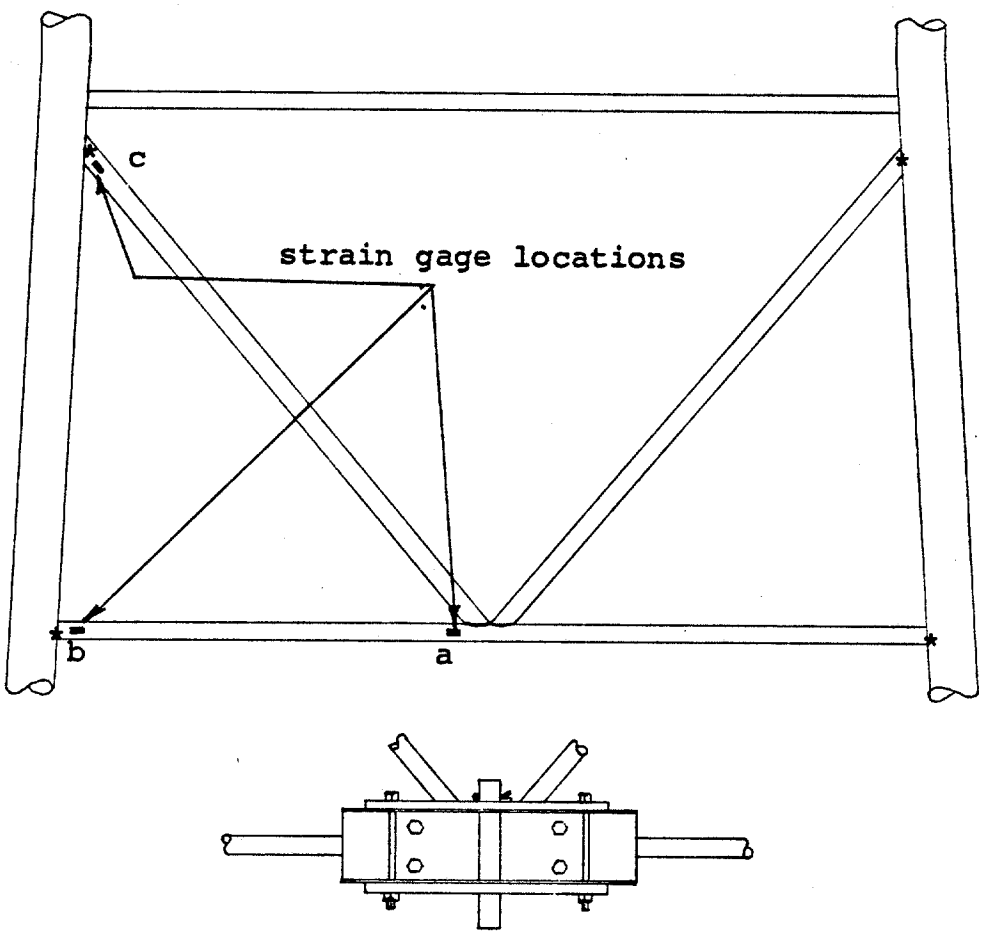
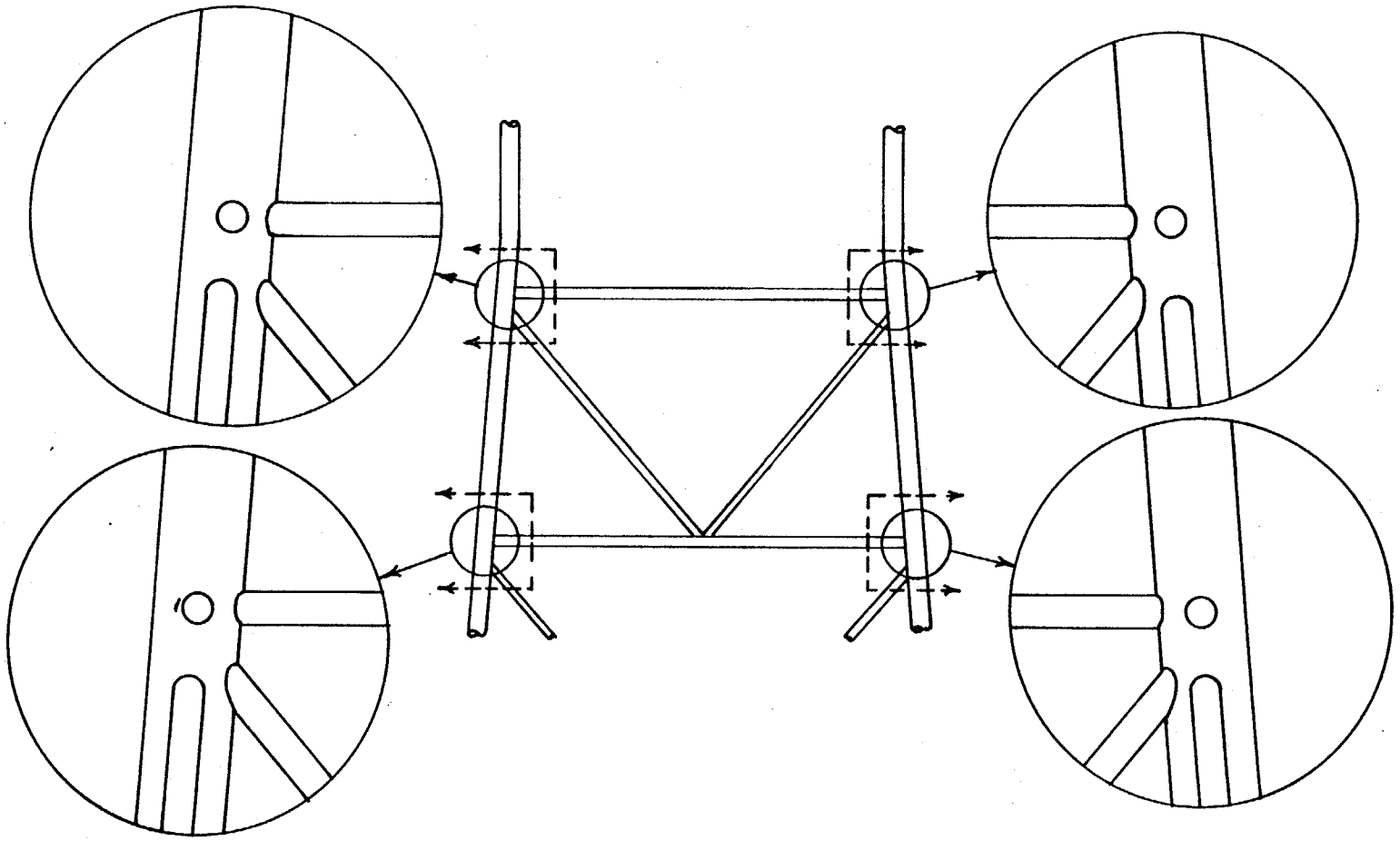
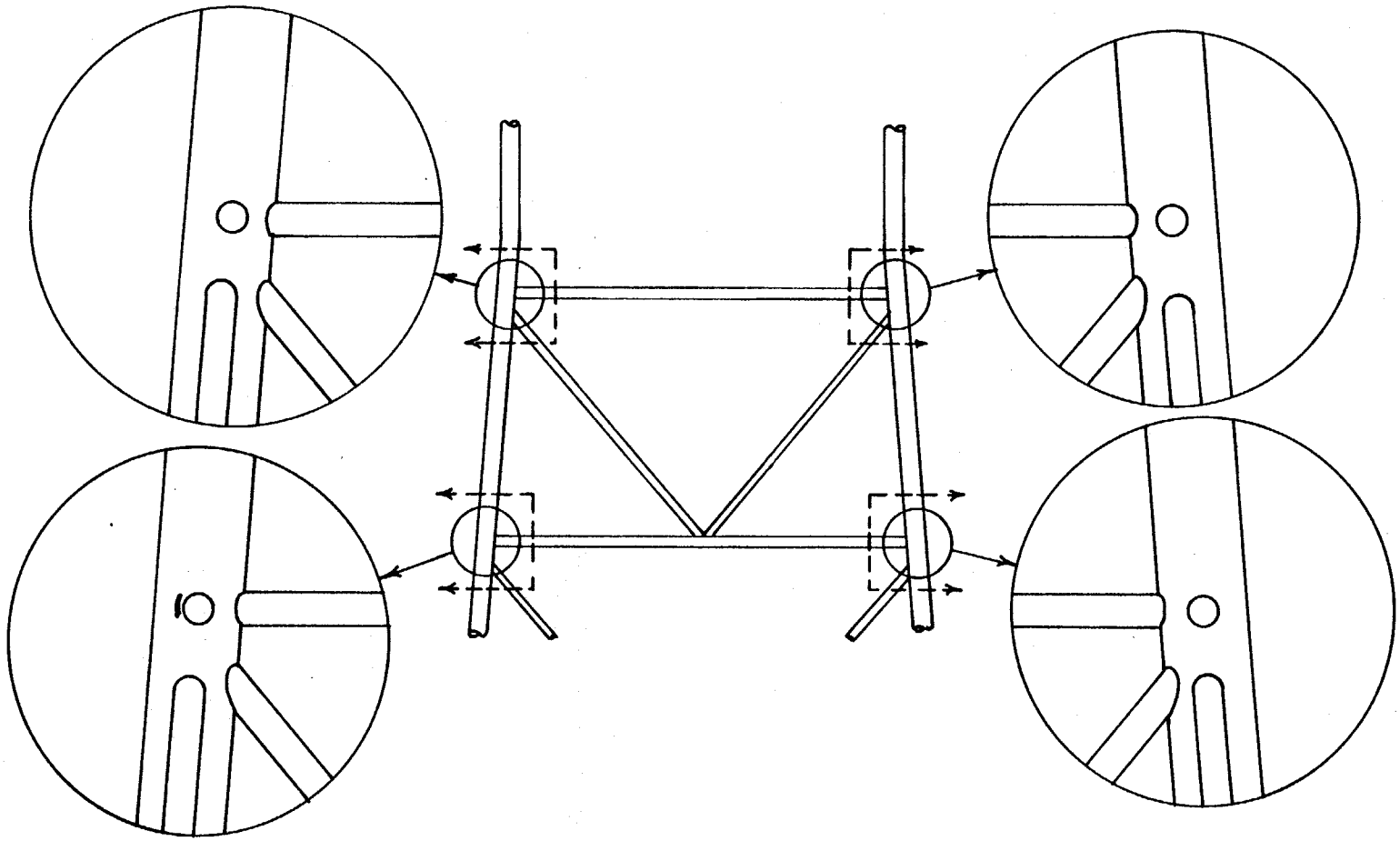


Figure 11: 'K' joint detail, showing strain gage and crack wire locations



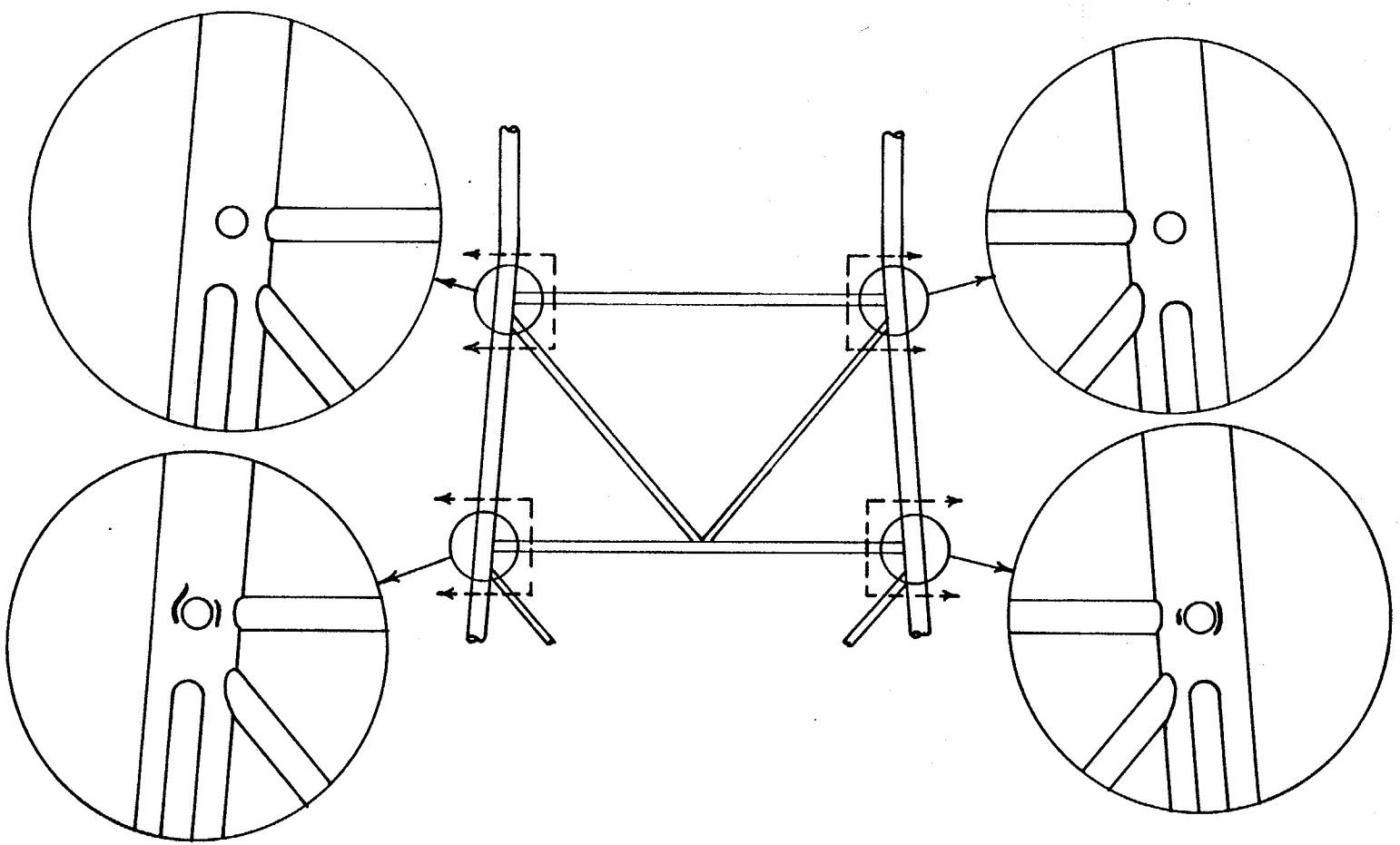
9926 Cycles

Figure 12a: Crack initiation sites and propagation details, test 1.



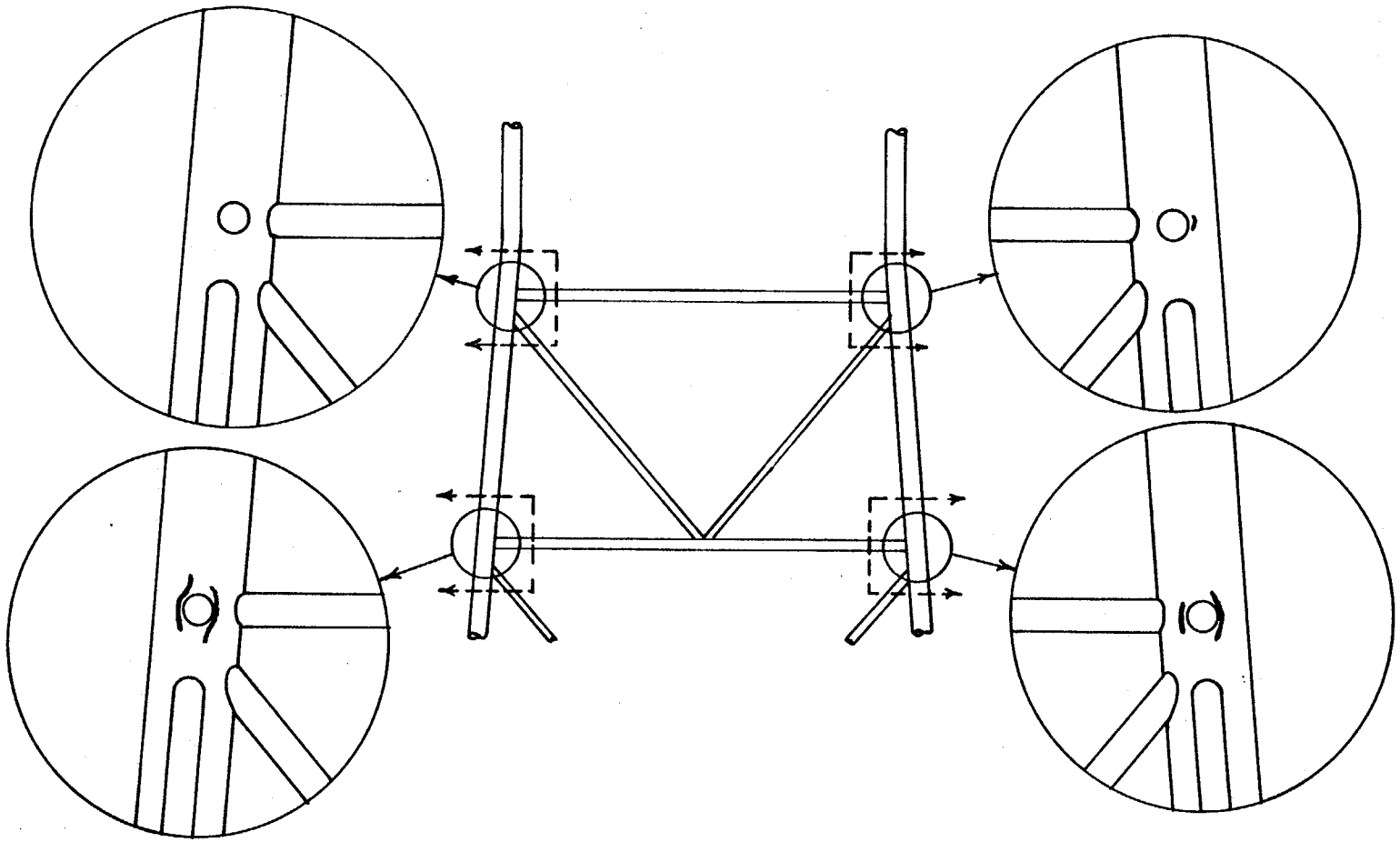
12145 Cycles

Figure 12b: Crack initiation sites and propagation details, test 1.



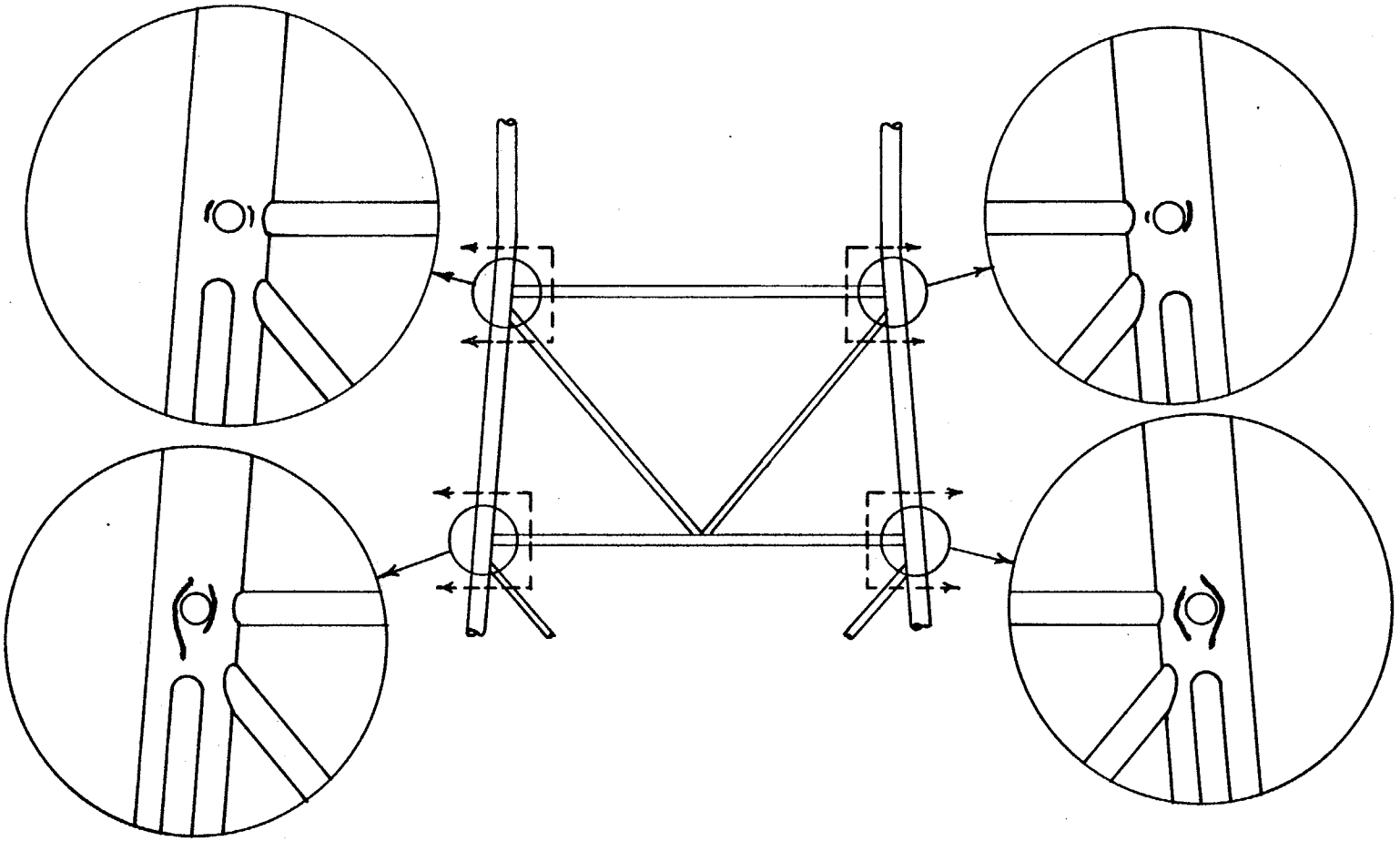
14655 Cycles

Figure 12c: Crack initiation sites and propagation details, test 1.



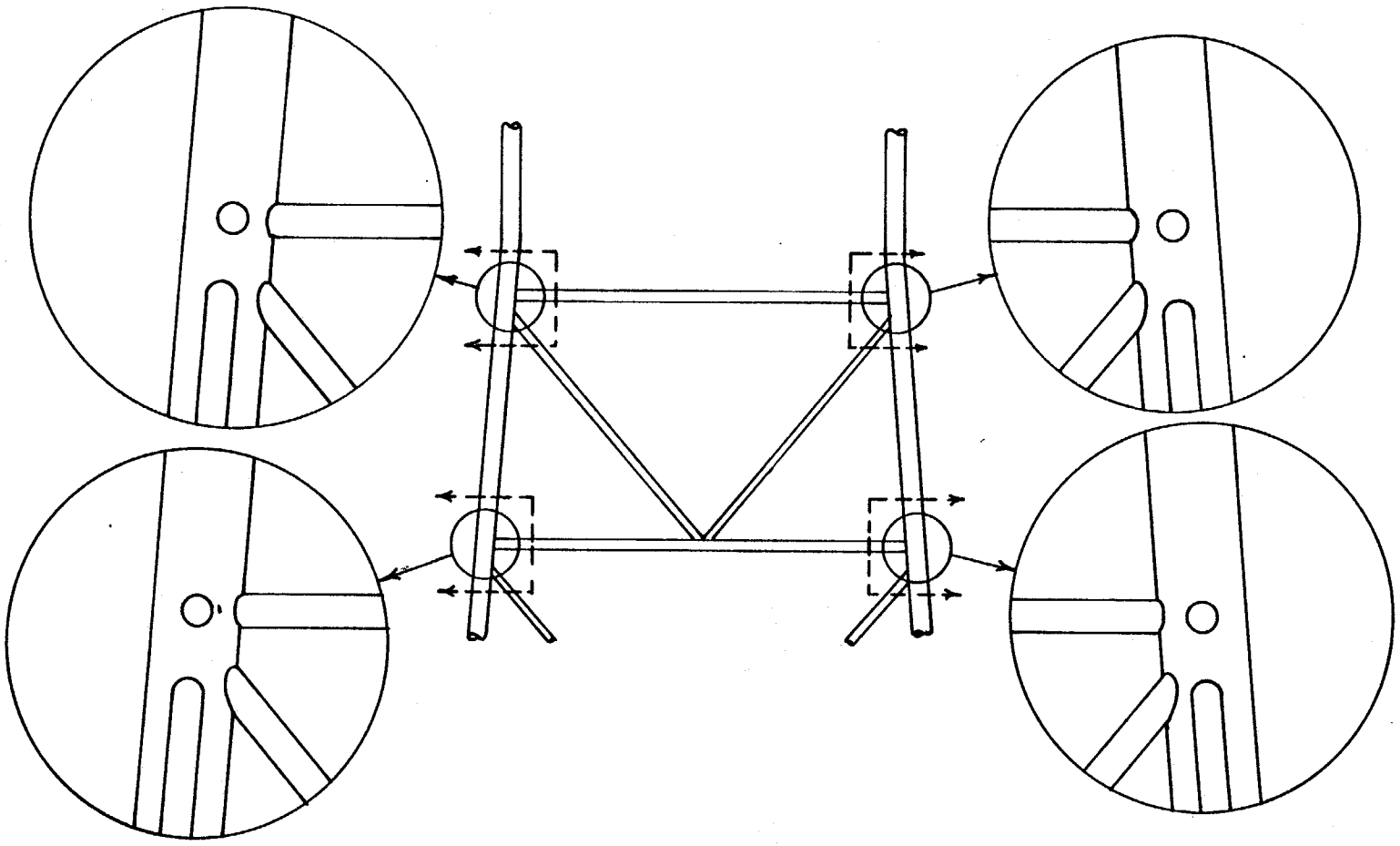
16365 Cycles

Figure 12d: Crack initiation sites and propagation details, test 1.



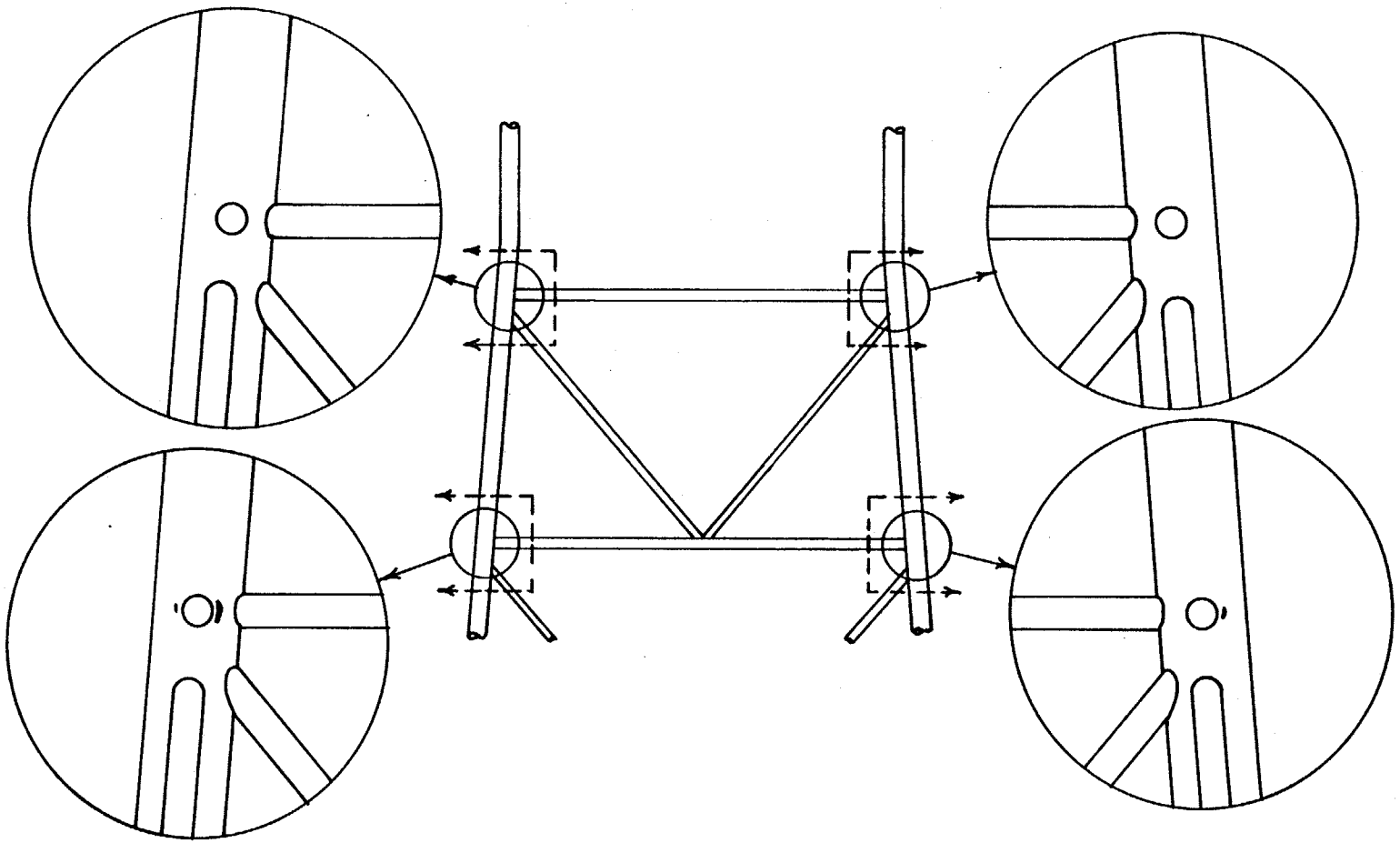
25545 Cycles

Figure 12e Crack initiation sites and propagation details, test 1.



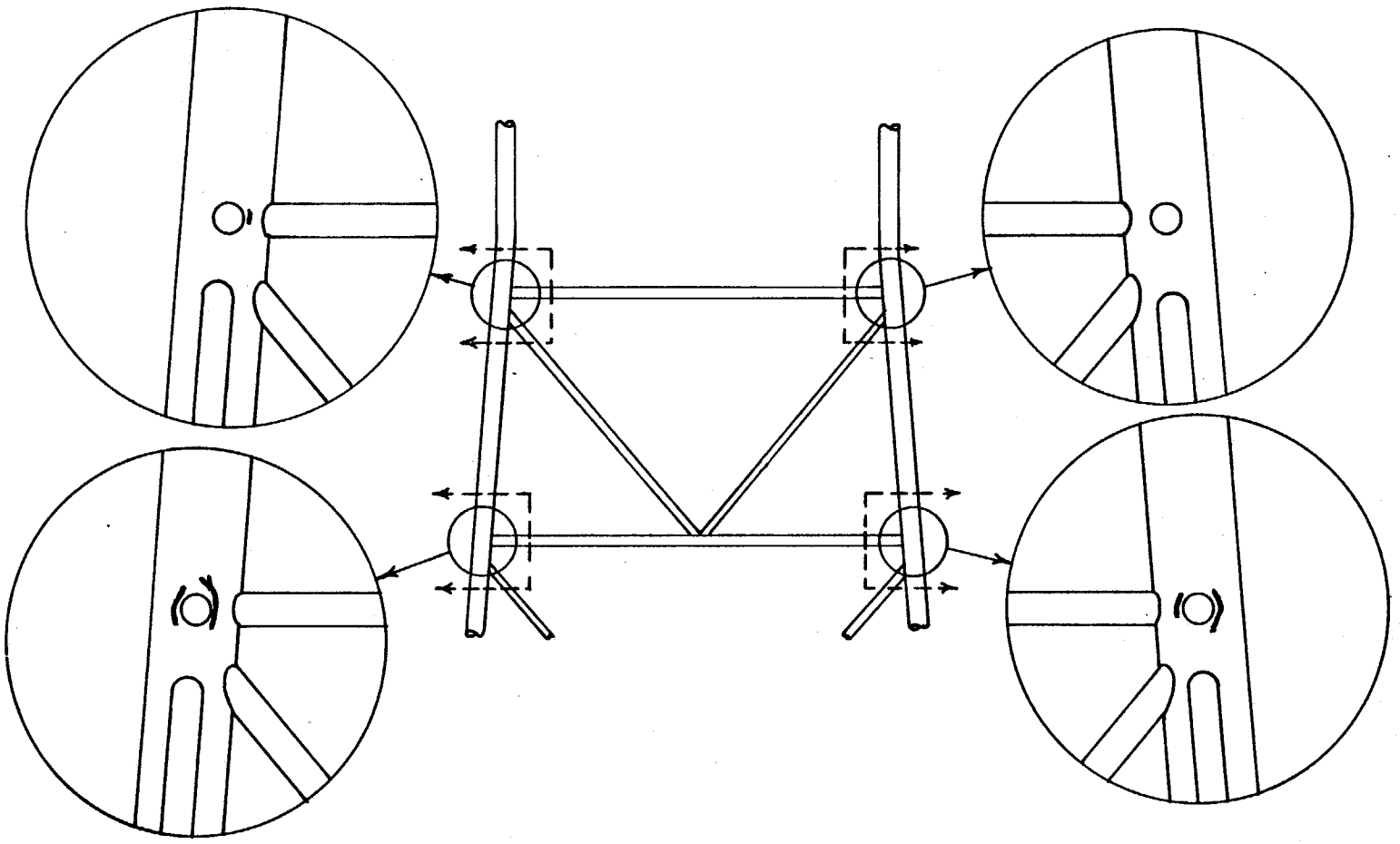
17010 Cycles

Figure 13a: Crack initiation sites and propagation details, test 2.



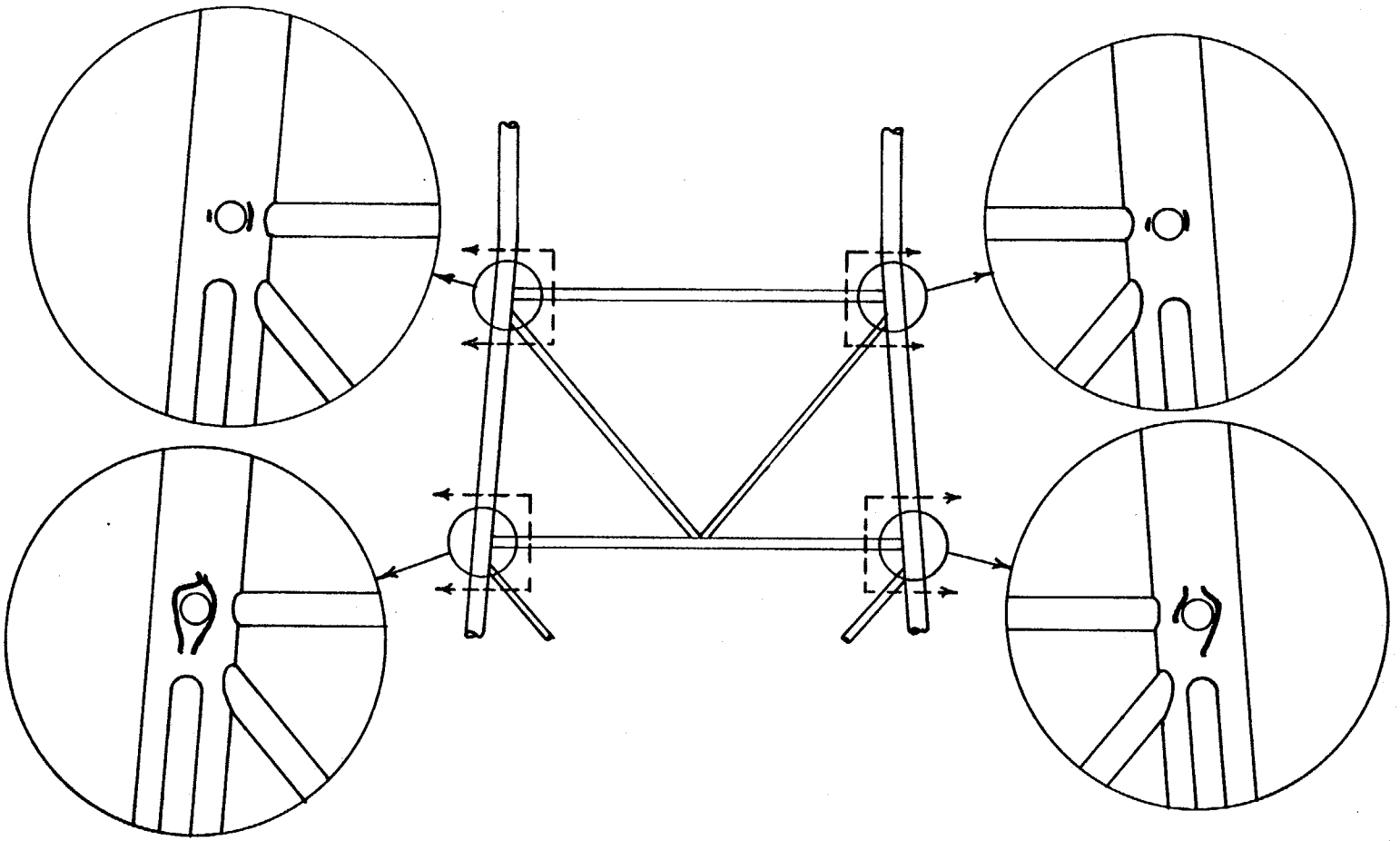
19572 Cycles

Figure 13b: Crack initiation sites and propagation details, test 2.



30372 Cycles

Figure 13c: Crack initiation sites and propagation details, test 2.



34632 Cycles

Figure 13d: Crack initiation sites and propagation details, test 2.

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